MTP Medical Technology Program

U.S. Department of Energy

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Portable Microwave Hematoma Detector

Diagnosing Head Injury Victims for Hematoma

Over two million head injuries are treated in emergency rooms every year in the U.S. Of these, about 500,000 hospitalizations result, 90,000 have long-term disability and about 56,000 deaths occur annually. A common result of head injury, which leads to complications and sometimes to death, is blood and cerebral fluid pooling between the skull and the brain. Known as a hematoma, these blood pools often result from brain trauma incidents. Victims can go for hours or days without presenting clear symptoms of the developing hematoma, yet coma and eventually disability or death can result from the pressure on the brain or brain stem. There is also a ten times greater chance that a head injury victim with a hematoma will die if surgery is delayed by more than 4 hours, but currently, there is no quick way to diagnose a hematoma. Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) scans are the present diagnostic tools but they are expensive and non-portable. The current procedure for screening head injury patients is:

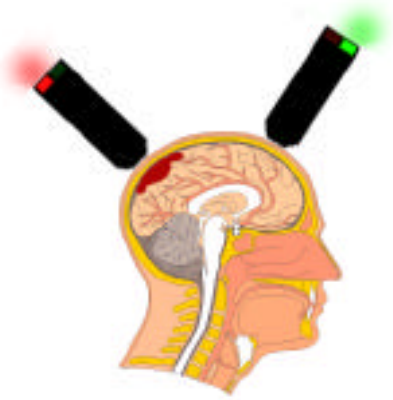
1. first responders to the scene of an accident evaluate the patient state through questions and observations of the patient's behavior and the accident situation. The evaluation can be inaccurate if the patient is drunk or has other injuries that impact the evaluation
2. Patients with known or suspected head trauma are sent for a CT scan. The decision to order a CT scan is done conservatively, i.e. even if it is not clearly warranted, as a precautionary measure.

Unfortunately, the cost of a CT is high. A typical head scan is about $500 - $800, and can cost much more if the patient must be sedated or closely monitored during the scan. In many cases, repeated scans of a single patient are necessary to monitor the development of his/her condition. The total time required for a scan is about 15 minutes, however, the actual time to diagnose a hematoma (or other problem) is usually limited by patient transportation, preparation and the need to have a radiologist read the scan. If the scan must be sent out for evaluation, the overall time can be between 30 minutes and 3 hours. In addition, a hospital may need to do many CT scans a day and at a typical ER, between 70% and 90% of CT head scans are unnecessary - i.e. are done for precautionary reasons and yield a negative result.

Micro-Impulse Radar-Based Hematoma Detector

Lawrence Livermore National Laboratory is developing a low-cost, battery-powered, non-invasive device for the screening of head injury victims. Our portable microwave hematoma detector is safe, battery-powered (9 volts), lightweight, reliable, non-invasive and simple to operate. It incorporates micropower impulse radar (MIR) technology, which can be mass-produced at very low cost. MIR devices transmit microwave radiation which penetrates into the body well, but is safe, at a power level which is an order of magnitude lower than that of a hand-held cellular phone.

The portable microwave hematoma detector transmits electromagnetic pulses which are recorded in the time domain using MIR fast pulse technology. The portable hematoma detector is manually scanned over the patient's head, while another version of the device will be mechanically scanned. The operator is signaled when a hematoma is detected. This enables rapid evaluation by health care providers. Its size and simplicity make the hematoma detector easily adaptable to a variety of situations.



LLNL's hematoma detector will be simple to use. A red signal on the detector indicates a hematoma. A green signal indicates no hematoma.

The LLNL portable microwave hematoma detector could be used immediately at the scene of an injury by the paramedic or first responder, in the ER, in local clinics, in hospital intensive care units and operating rooms. It would allow rapid testing of patients prior to CT scanning; eliminating unnecessary CT scans, or could possibly replace the use of CT for examining some head injury victims. It would save many lives and reduce long term morbidity for head injury victims by reducing the time of diagnosis. It would

also allow convenient repeated scans to monitor the growth of a hematoma. It would greatly reduce the medical costs associated with testing and treating head injury victims, as well as reducing the costs of patient rehabilitation and convalescence by reducing the morbidity resulting from current treatment time delays.

Role of the low-cost, Portable Hematoma Detector

The "big win," in terms of both cost and time of diagnosis, comes if the device could reduce the need for CT for patient screening in the ER. It would also have great value for scanning patients that cannot be given a CT scan due to other injuries. This generally means those who must go directly to surgery, i.e. those with life threatening chest or abdominal injuries. The device would be a fixture in trauma centers because it would allow immediate care of severely injured or difficult to handle patients such as children. Even if the device is not used as a replacement for CT screening, but instead as a pre-screening device (prior to deciding to get a CT scan), it would be of great value. This is because of the number of "unnecessary" CT scans that are taken. A pre-screening device would reduce the number of unnecessary CT's, thereby lowering costs and freeing up the CT scanner for use on the truly critical patient. Pre-screening is also important particularly for children since it is often the case that a child must be anesthetized in order to get him / her through the CT scan. Sedation of a patient is undesirable, very expensive, adds risk to the medical care and adds to the time for diagnosis. Reducing the number of unnecessary (negative result) CT scans will therefore be of tremendous value and provide much more cost-effective medical care.

We are seeking an industrial sponsor to complete the development and commercialization of the portable microwave hematoma detector. Primary users of the device will include ambulances, major emergency and trauma centers, general hospitals, physician offices and acute care clinics.

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